ART. II.—*On the Cause of Intermittent and Remittent Fevers, with Investigations which tend to prove that these Affections are caused by certain species of Palmellæ.* By J. H. SALISBURY, M. D., Professor of Physiology, Histology, and Pathology in Charity Hospital Medical College.

ALL views upon the origin of malarious diseases, up to the present, have been purely hypothetical. No one has attempted a detailed series of investigations connected with the expectoration and other excretions of the human system; the bodies suspended in the night air of malarious levels and inhaled, and the tracing of such abnormal bodies to their true source; and finally the developing of ague paroxysms with these bodies. With these few remarks, we will proceed to a brief description of our researches regarding the origin and cause of intermittent fever.

During a lengthy series of careful experiments, connected with camp diseases, and those affecting vegetation, as the "curl in peach leaves," and the "blight in apple, pear, and quince trees," &c., and in studying the causes and consequences of fermentation, gangrene, decay, and the changes going on in diseased tissues; I was led by some of the experiments connected with bodies suspended in the atmosphere, to inquire into the causes of fevers, and especially those of an intermittent type.

Intermittent fever began to show itself in the rich malarial districts of the Ohio and Mississippi valleys, in 1862, during the month of May. It did not, however, prevail to any great extent till the months of July and August. The weather had been unusually damp up to about the first of July. During the months of July, August, and September there was scarcely any rain. Springs and streams became very low, swamps and humid grounds became dry, vegetation almost entirely ceased to grow, and the country presented all the signs of a severe drought. Soon after the dry weather commenced, intermittent fever, in malarial districts, became quite general. The disease rapidly increased during the months of July and August, till it had invaded nearly every family on ague levels.

The observations were commenced by examining microscopically the expectoration of those labouring under intermittent fever, and who resided upon ague levels and were exposed during the evening, night, and morning to the cool, heavy, damp exhalations and vapours rising from stagnant pools, swamps, and humid low grounds; in short, those who were constantly immersed in a malarial atmosphere, and where every one was more or less affected with symptoms of miasmatic poisoning.

The first salivary secretions and mucous expectoration of the morning, were those used. In these secretions occurred a great variety of zoosporoid cells, animalcular bodies, diatoms, dismidiæ, algoid cells and filaments, and

fungoid spores. The only constant bodies, however, uniformly found in all cases, and usually in great abundance, were minute oblong cells, either single or aggregated, consisting of a distinct nucleus, surrounded by a smooth cell-wall, with a highly clear, apparently empty space between the outside cell-wall and nucleus. Their peculiar appearance satisfied me early in the examination that they were not fungoid, but cells of an algoid type, resembling strongly those of the palmellæ. This part of the inquiry was extended to a great number of individual cases, on the low malarial levels, and to persons residing on elevated lands near and far removed from malarial influence. Whenever the mucous secretions were examined, from persons residing above the summit plane of ague, these bodies were invariably absent. They were found only below the summit ague line; whereas, diatoms, dismidiæ, fungoid spores, and animalcular bodies, extended to some extent to all heights above the ague line; especially were they found in the vicinity of damp high grounds and streams.

After satisfying myself that these minute cells were the only forms found that could be relied upon as constantly present, on malarial levels and not present above them, my next step was, if possible, to trace their source and character.

In order to effect this, I commenced suspending rectangular plates of glass, sixteen by twenty-two inches, about one foot above the surface of stagnant pools and marshy grounds that were partially submerged. The plates were placed horizontal, each resting on four pegs, a single peg supporting each corner of a plate. The plates were placed in position at dusk, and secured in the morning before sunrise. Invariably the under surface of plates would be covered thickly with large drops of water. This condensed vapour was subjected to careful microscopic examination. Many of the cells were found that occurred in the expectoration; but none of those minute oblong cells, so uniformly present in the morning expectoration, were met with. On the upper surface of the plates, however, these bodies were found in considerable numbers. I repeated these experiments for many nights, varying widely the localities, with the same results.

In passing to the stagnant pools and swampy grounds southeast of the city of Lancaster, Ohio, to suspend the glass plates, I had to pass over a rich, peaty prairie bog, where the water had become mostly dried off, and the surface broken by the tread of cattle. I had noticed that in walking over this ground, a peculiar dry feverish sensation was always produced in the throat and fauces, often extending to the pulmonary mucous surfaces, and that my expectoration was, after returning, uniformly filled with the minute oblong cells above described. This drew my attention to the partially desiccated peaty prairie bog, where the surface had been recently broken by the tread of cattle. I discovered on the recently exposed earth, what appeared to be a whitish mould, or more closely the incrustation of some salt. I here suspended the plates of glass, and the following morn-

ing, much to my delight, found the inferior surface of the plates covered with the minute cells, which I was in pursuit of. I immediately returned to the bog and secured samples of fresh earth, which were covered with the incrustation, and some which were not, and also portions of the boggy turf. On placing a fragment of the incrustation under the microscope, it was at once discovered to be made up of aggregated masses of the minute cells so uniformly met with in the expectoration of those exposed to the influence of the heavy cool vapours of malarial levels. It was further seen that these cells were algoid, and emanated from plants of a palmelloid type, as we had previously suspected. That there were several species, and that in the larger ones, grew several species of mucidinous fungi.

The locality where these first results were obtained is situated on the southeast side of the city of Lancaster, between the canal and railroad, and just east of the depot and starch factory. Here stretches out to the southeast, along the canal, a low peaty, prairie bog, and in its vicinity the surrounding bottoms are low and humid. The portion of the town (3d ward) adjoining this bog, or all of it situated below a line about thirty-five to forty feet above the bog, has always been a fertile field for intermittents. Those living immediately on the edge of the bog are frequently subjects of ague, yearly, from May till November. August and September are usually the worst months.

To determine how high above the low grounds the bodies found on the under surface of the suspended glass plates were elevated, both at night and day, a small apparatus was used, which consisted of a glass screen standing perpendicular, and in front of it a large funnel, with the broad open end pointing from the screen, and the small end terminating within one-half inch of it. This was arranged on a pivot, and so constructed that the force of the currents of air kept the broad mouth of the funnel towards the wind. When an observation was to be made, the screen was covered with a concentrated solution of chloride of calcium, and the apparatus suspended at the desired height and left for one hour. The wind passing through the funnel, and falling upon the coating of calcium, deposits its small suspended particles upon the smeared screen. On examining under the microscope the liquid on the screen, after an hour's suspension, all the bodies floating in the atmosphere are found. By suspending this apparatus at different heights above the low ague levels, at all hours of the day and night, the following facts have been ascertained :—

1. That cryptogamic spores and other minute bodies are mainly elevated above the surface during the night. That they rise and are suspended in the cold, damp exhalations from the soil, after the sun has set, and that they fall again to the earth soon after the sun rises.

2. That in the latitude of Ohio, these bodies seldom rise above from thirty-five to sixty feet above the low levels. That in the northern and

central portions of the State, they rise from thirty-five to forty-five feet, while in the southern, from forty to sixty feet.

3. That at Nashville and Memphis, they rise from sixty to one hundred feet and more above the surface.

4. That above the summit plane of the cool night exhalations, these bodies do not rise, and intermittents do not extend.

5. That the day air of malarial districts is quite free from these palmelloid spores, and from causes that produce intermittents.

With the view of tracing more carefully the symptoms of the local fever, produced in the mouth, fauces, throat, and lungs, by inhaling the cells and sporoid bodies emanating from the vegetable organisms forming the incrustations on the drying, rich, freshly exposed soil of malarial grounds, I visited, Sept. 2d, 1862, the bog above referred to and spent some time in wandering over its surface, examining the incrustation, and in collecting samples for further microscopic study. In a very few minutes after my arrival on the bog, I began to feel a dry, feverish, constricted feeling in the mouth, fauces, and throat. This feeling increased till the fauces and throat became very unpleasantly parched and feverish. The opposite walls in swallowing adhered together, and the normal mucous secretions were quite entirely checked. There was a constant desire to swallow and hawk and spit, without being able to raise much, or to relieve in the least the dry, feverish, constricted sensation. This feeling soon extended to the bronchial and pulmonary surfaces, which became dry, feverish, and constricted, with a heavy congested sensation and dull pain. These peculiar symptoms lasted about two hours after leaving the bog before they entirely disappeared. The malarial matters inhaled appeared to be poisonous to the surfaces with which they came in contact; and there seemed to be an effort on the part of the exposed mucous surfaces to close up their absorbent and secretory organs, until this poisonous matter could be dislodged by the swallowing, and hawking, and spitting which they excited.

On the morning of the 3d of September I again visited the bog, to obtain more specimens for examination, and to study still further the symptoms produced by inhaling the malarious matters of ague bogs. I remained walking over the surface for about half an hour. The same train of symptoms manifested themselves that I experienced on the previous visit, being quite as severe and lasting quite as long.

On the evening of the third, just at dusk, I again visited the bog to suspend glass plates. I remained about fifteen minutes. I had scarcely left the ground when the dry, constricted, feverish feeling of fauces and throat commenced; and I experienced the same train of symptoms as on the previous occasion. Between this and the last of October I daily visited this and other similar bogs, always with the same result.

On Sept. 18th, Dr. Effinger, at my request, accompanied me over the bog, with the view of determining whether he would be affected with the

same train of symptoms as myself. In a very few minutes after our arrival the symptoms began in his case, as in my own, and he described them precisely as they have been already stated.

On Sept. 20th Dr. Boerstler walked over the bog with me and experienced the same symptoms. Dr. B. remarked that he had often experienced the same, or similar sensations before, without knowing the cause.

Numerous other persons, who visited with me ague grounds, were invariably affected with the same train of symptoms.

The only constant foreign bodies found in the expectoration of those affected with the above local symptoms produced by walking over ague grounds, and in the expectoration of those immersed in the night emanations of malarial levels, were the minute palmelloid cells previously described. The source of these cells was found to be the palmelloid plants growing in such profusion on the drying soil of ague lands during the prevalence of intermittents. It is hence inferred that the minute cell emanations from these low vegetable organisms are capable of exciting local fever in the mucous surfaces with which they come in immediate contact; and further, that there is strong presumptive evidence from what has been previously determined, that by repeated and continued exposure to them they may cause general fever of either an intermittent or remittent type. This will appear more conclusive after perusing carefully the observations and experiments which follow.

On the northwest side of Lancaster, in the vicinity of the old canal mill, is another district of considerable extent, where the people are universally subject to ague. With the view of exploring for the local cause, I visited the locality Sept. 12th. Immediately west of this infected district is a wide low rich prairie. A few rods south of the mill and also west of it, I found the ague palmellæ growing luxuriantly, covering the surface of the soil recently thrown up by moles and exposed freshly by the tread of cattle. In fact, over the entire prairie, wherever the soil had been recently exposed the plants were developing in profusion. While collecting samples for microscopic examination, I became affected with all the peculiar symptoms of local fever previously described.

On the north edge of Lancaster, immediately on the west and south sides of Mount Pleasant, is another locality where ague prevails in its worst form; often running into fever of a remitting and continued type. There is a low belt of ground running through this locality, along which are stagnant pools of water. Around these pools and in the rich humid broken soil of the vicinity, I found the ague palmellæ growing in profusion. While collecting specimens for examination, I experienced all the symptoms of local fever as previously mentioned.

On the Columbus road, about one mile northwest of Lancaster, on the farm adjoining on the north the old Tallmadge place, occurred suddenly, about the middle of September, a severe case of ague in a strong healthy

young man. This locality had been previously exempt from the disease. I visited the point with Dr. Effinger, who was attending this patient. About fifteen rods south of the house, we discovered a new ditch about ten rods long, running through a piece of low, black, humid ground. The freshly thrown out earth and the sides of the ditch were covered with ague palmellæ. While examining the soil along the ditch and collecting specimens for the microscope, the mouth, throat, and pulmonary surfaces became dry and congested as in previous instances.

This ditch was dug by the young man about two weeks previous to his attack.

On Sept. 21st, in company with Dr. Effinger, I visited Mr. C. and family who reside five miles northwest of Lancaster, in a locality previously exempt from ague. Mr. C. was attacked with a severe form of the tertian type of intermittent fever on Sept. 1st, and his wife on Sept. 3d. The paroxysms were arrested on the fourth day of the disease with quinia, by Dr. E., their attending physician. Relapse on the 15th; was arrested after the second paroxysm. Both Mr. C. and wife, on Sept. 21st, were much debilitated, pale and sallow. Mr. C.'s house stands upon the edge of a low terrace, elevated about 30 feet above the prairie bottom, which approaches within fifteen rods of it, on the south and southwest sides. About fifty poles southwest of the house, a small creek, running through the prairie bottoms, empties into the canal. This creek, during rains, washes in sediment and makes a troublesome bar across the canal. The *lessees* of the canal had purchased, a short time previous, of Mr. C. an acre of ground at the mouth of this creek for the purpose of excavating there a reservoir to receive the sediment of the creek. About the middle of August, the workmen began the excavation. The soil excavated was a rich, peaty loam, with some black and blue clay. Very soon after the excavating was commenced, the workmen began to be taken down with ague, and very soon nearly every man was labouring under the disease. On Sept. 1st Mr. C. was attacked; on the third Mrs. C. was taken down with the same type. On Sept. 21st Dr. Effinger and myself visited the excavation, and found the excavated soil covered with "ague plants," a quantity of which were collected for examination. While gathering them, both Dr. E. and myself were affected with the symptoms of local fever as previously described. Mr. C., who accompanied us to the excavation, became so much affected in the throat, fauces, and lungs, that he had to retire from the place. Mr. C. stated that he and his wife slept in a room in the southeast corner of the house, on the lower floor; while the children, seven in number, ranging in age from two to fourteen, slept on the second floor, immediately over theirs. He and his wife were attacked with ague on the first and third of September, while all his children were entirely exempt and perfectly well. He also stated that early every morning he noticed that the "fog" from the reservoir grounds extended to the house, and rose

about two-thirds the way up the first story, and entered freely his sleeping apartment through the open window, and had the same odour as the soil containing the ague plants, and produced the same febrile symptoms in the throat and fauces. He never had noticed this fog to rise as high as the second story window where his children slept. The foggy vapour dissipated soon after sunrise and before his children were up. He stated that he had lived there over forty years, and had never had the ague before. That all his neighbours around, on the same and lower levels, were now suffering from the disease. I mention this case particularly, as it is of peculiar interest, showing in a striking manner a quite fixed and marked line indicating the summit plane of invasion, above which the malarious causes do not extend.

In the eastern half of the city of Lancaster stands a hill, having an area of about one hundred acres. Upon its sides and summit the finest portion of the town is built. This hill rises to the height of about sixty feet above the adjacent low prairie bottoms, on its south and southeast sides. The heavy, cold, night vapours, emanating from these bogs, rise within fifteen feet of its summit. The upper surface of these vapours, in the morning before sunrise, is seen, from the surrounding hills, to be a broad, level plain, limited by its contact with the adjacent hills. The line described around this hill, by the upper surface of these vapours, is a horizontal one, and marks distinctly the ague line. All of those living on the hill above this line are exempt; all below are subject to the disease. The line is so well defined that, of people living on different floors of the same house, those on the upper floor are exempt, while those on the floor below are frequently all down with the disease. If any cases occur above the summit ague plane, they are found to be in such persons as frequent the lower levels during the evening or early morning.

During the summer of 1862, and especially during the months of August and September, intermittent fever prevailed to a remarkable extent in the town of Carroll, situated on the canal, between Lancaster and Columbus. The site of the town and much of the surrounding country is low, and many boggy places occur along the canal. During the months of August and September, the old and young of almost every family, including physicians, were down with ague. I visited this locality several times during these months, and found the ague palmellæ growing abundantly on the partially desiccated, boggy soil, along the canal, through the town and vicinity, and found the morning expectoration of all more or less filled with the minute cells of these plants.

Numerous other localities were visited where intermittent fever prevailed, and in every instance, without a solitary exception, the ague plants were found growing in the immediate vicinity of the disease, and in no instance were they found when the disease did not occur.

An interesting instance of the readiness with which the emanations from

these ague palmellæ produce the disease, presented itself, the last of September, one mile west of the city of Lancaster. At this point, a few poles south of the pike, and about fifty poles west of Judge Van Tromp's residence, is a small pond, that affords water to a small flouring mill. During the months of August and September, the water became low in this pond, and the ague palmellæ made their appearance in abundance on the drying, peaty mud, from which the water had retired. From the time these plants appeared, till the last of September, the wind was in the south. There being no buildings on the north side of the pond, there was no appearance of the disease. Near the last of the month the weather became cool, the wind changed and blew briskly from the north and northwest. About thirty poles a little southeast of the pond, twenty-five to thirty feet above it, on the hillside, a strong, healthy, labouring family resided, who had been, up to this time, entirely free from ague. The wind blew over the pond directly towards this house. About the fourth day, several members of the family were taken down with the disease. The wind now suddenly changed to the southeast, blowing across the pond, directly towards the tollgate, about forty poles distant, where a family resided in which were four small children. This family had been, up to this time, also exempt from the disease. The third or fourth day, two cases of intermittent fever occurred among the children, and soon after the father was attacked.

Here is an interesting instance of the transmission of the malarial influence by the winds. These families had lived for nearly two months in the vicinity of an abundant crop of ague palmellæ, without taking the disease. The pond being small, banks abrupt, and soil around dry, no fogs or night vapours, to any extent, emanated from the place to diffuse the poison. What malarial matters there were emanating from this point, were borne north by the prevailing wind. As soon, however, as the wind changed, and blew over the pond towards the neighbouring abodes, the disease, in a few days, appeared.

A very interesting instance of the sudden occurrence of intermittent fever, at a point where it was never known before, occurred at the residence of Hon. John T. Brasee, one and a half miles west of the city of Lancaster, upon an elevated ground, about one hundred feet above the ague levels, and far removed from them. The locality has always been, from the first settlement of the country (sixty-five years), exempt from intermittent fever. The farm is abundantly supplied with fine large springs of pure freestone water, cold and soft. Near Mr. B.'s residence, one of these springs occurs. It had formerly supplied a small fishpond, containing about ten square rods of surface. This pond, several years ago, had been drained, and the rich alluvial bed had become covered thickly with grass. About five square rods of it were spaded up, for the first time, in the month of July, 1863, for celery and vines. Ague palmellæ began to appear on the freshly-spaded soil about August 1st. A portion of these were white, like those usually

met with, while others were of a brick-red colour, giving to the surface the appearance of having been sprinkled over with a thin layer of brickdust. Aug. 8th, Mr. Brasee and wife, who slept on the lower floor, began to feel languid, with loss of appetite, and pains in limbs and back. 20th, Mr. B. had his first chill, which came on about 12 o'clock (noon). The paroxysm lasted about three hours, and was very severe. 22d, Mrs. B. had her first paroxysm, which continued for about three hours, and was also very severe. 23d, the farm-hand and his wife were attacked. Mr. B.'s residence stands about ten rods north of this patch of ague ground, and his tenant's house about fifteen rods south of it.

August 22d, I examined the patch minutely. It was perfectly covered with ague palmellæ. Those growing on the dry prominences of the soil were white; those on the retired, smooth, and more damp portions, were the colour of brickdust. The whole surface had the appearance of having been sprinkled over with brickdust and lime. No cases of ague occurred in that portion of the family who slept up in the second story, nor were there any premonitory symptoms of that disease.

August 24th, the small ague patch was covered, at my suggestion, with a layer of straw, to the depth of six inches. On suspending glass plates over this for several nights, I obtained no trace of the palmelloid spores or plants, while before the straw was spread over the plants, the glass plates were covered nightly with them.

The four cases of ague readily yielded to treatment, with no subsequent manifestations of the disease. The straw, in this instance, prevented the further development of the ague palmellæ, and prevented the spores of the already mature vegetation from rising in the damp night vapours.

Another interesting instance came under my observation in the city of Columbus, Ohio. On a visit to this place, during the last of September, 1863, I met Mr. Theodore Tallmadge, who stated to me that his children were all being attacked with ague. He stated that his family had been spending a few weeks at White Sulphur Springs, and that about two weeks before, they had all returned home hearty and well. In a few days after their return, one of his children was attacked with ague, and soon after, another. This surprised him, as ague had not previously been known to occur at his residence. Feeling satisfied that there must be some local cause, I, on the following morning, repaired to his house and examined his grounds. I immediately discovered a prolific crop of ague palmellæ directly in the rear of his kitchen, in some new, peaty soil he had drawn there, a few weeks previously, to level off the surface. I directed him to sprinkle the surface of the new soil thickly over with caustic lime, after which he had no more cases of the disease in his family.

On the rich limestone lands of the Maumee and Miami Bottoms, in Ohio, the black, alluvial lands of the Wabash and its tributaries in Illinois and Indiana, the fertile prairie lands of these States, and Missouri and Iowa,

and on the rich, low, limestone, and alluvial lands of Kentucky, Tennessee, and Mississippi, ague palmellæ develop in great profusion, especially during the months of July, August, and September. For the most part, wherever the soil is free from lime, and the water soft, the ague palmellæ developed are mostly white, or slightly tinged with yellow and green, and intermittents are comparatively free from congestive tendencies, and the types better marked, the eliminating organs much less liable to become badly deranged, and the paroxysms more readily yield to the tonic influence of quinia and iron, and the disease is quite promptly and easily controlled, unless the system be exposed to the continued and constant action of the cause of the affection. In limestone regions, however, where the water is hard and the soil highly calcareous, there is a remarkable tendency, during the months of July, August, and September, for the malarious portions of the soil to become covered with palmellæ, mostly of a different colour from those found on soil not calcareous. On calcareous soil the palmellæ are usually pink, brick-red, greenish, or yellowish. The brick-red and greenish plants are the most abundant. In such localities, intermittents are apt to assume a congestive type, the functions of the eliminating organs (epidermic and mucous surfaces, and portal and renal glands) become much deranged and partially suppressed, oxaluric, and often phosphoric states follow, and, in this condition of the system, quinia, iron, and arsenic, alone or combined, do but little good, and often in old and bad cases, tend to aggravate the disease. If, however, in these severe forms, the functions of the eliminating organs be restored to their normal or to increased activity, by the proper diuretics, diaphoretics, expectorants, and alteratives, the paroxysms readily yield to the tonic and anti-zymotic influence of quinia and iron.

College Hill, Nashville, Tennessee, rises from 75 to 100 feet above the level of the Cumberland, which flows around its northern and eastern base. Upon its summit is an area of from six to ten acres. Here stands the University of Tennessee, and the residences of several of the faculty. When the Federal forces drove the Confederates from Nashville all of the high points or eminences, in and around the city, were fortified, for the better defence of the place. This hill was strengthened by a ditch six feet wide and four feet deep, with the excavated earth thrown on the outside, and running around on the eastern and southern brows which face the adjacent country. Soon after the University buildings were appropriated for hospital purposes. This high point was supposed to be peculiarly healthy from its elevated airy position, overlooking most of the city and surrounding country. As soon, however, as the warm weather of May and June set in it was found that this high ground was quite malarious, giving rise to a peculiar type of congestive intermittent that was very severe, producing in some instances death. The attendants were more subject to the disease than the inmates of the wards. This, probably, arose from the

fact that the former often exposed themselves to the evening vapours and exhalations outside, while the latter were mostly confined to the wards.

This peculiar type of intermittent became much more severe during the months of July, August, and September. The surgeon in charge, Dr. Lynde, was under the impression that this malarial influence came from the low ground to the east of the hill which bordered on the river, and which was half a mile distant and 100 feet below. This, on careful inquiry, was found to be highly improbable, as the malarial influence was much less marked on this low ground than on College Hill. On carefully examining the soil on the perpendicular sides of the ditch, which was dug to strengthen the place, it was found covered completely with cryptogamic vegetation, forming, in places, a greenish, and in others a brick-red film on the surface. Samples of this soil were preserved in boxes for microscopic examination. On my arrival at Cincinnati, three days after, this vegetation was carefully examined under the microscope, and found to be composed of green confervoid filaments and palmellæ, having mostly a pale green and a brick-red colour. The vegetation was very prolific and abundant. The palmellæ were of different species from those met with on non-calcareous soils, and were similar to those in districts where intermittents are of a congestive type.

Occasionally the soil on the hill, where it had not been disturbed, was covered slightly with this same vegetation. This was noticed all through the city and surrounding country wherever there were any indications of a malarious tendency. It was not, however, noticed in any great abundance, except where the fresh soil had been thrown up to a depth below where it had been usually disturbed in cultivation.

The city of Nashville stands on a series of small conical limestone eminences, which rise from 50 to 100 feet above the river. The limestone comes to the surface, or nearly so. This is so much the case that the rock is perfectly bare, and denuded of soil, over at least one-fourth of the surface, while the balance has a covering ranging from two inches to four feet in thickness. Wherever a cellar is dug it is sunk into the solid rock. The same may be said of all sub-drains and sewers. The limestone is usually either porous, shaly, or massive, and is rich in fossil remains.

The soil on College Hill is rather deeper than on most of the surrounding eminences, and the summit has a larger and more level area. The digging of this defensive ditch changed the health of the locality, so that now, instead of being the healthiest locality in and around Nashville, it has become decidedly the most malarious and sickly.

On the limestone soil surrounding *Louisville, Ky.*, and in *Jeffersonville*, opposite, similar species of palmellæ are developed upon the soil to those found at Nashville. All the low limestone lands in this region appear to be more or less malarious. Those just above Jeffersonville, where is erected the U. S. G. Hospital, on the Chestnut Hill plan, are very malarious. This site is on a low terrace, about 70 rods back from the

river, and rising about 20 feet above the river bottom. Immediately upon the brow of this terrace is located the hospital. The grounds had several sink holes, filled with stagnant water, which now have been filled up. Around the base of the terrace, springs, for nearly a mile in length, make out, forming a boggy, swampy strip of ground, from 10 to 20 rods wide. The south wind blows over this directly up to the hospital. It is made up of a black sandy muck, underlaid with stiff clay. This soil produces, during the months of July, August, and September, abundant crops of ague palmellæ. On this account the hospital is unfortunately located.

The low grounds around *Cincinnati and Covington*, during the months of July, August, and September, produce the ague palmellæ to some extent, and are malarious. Intermittent fever, often severe, is here met with.

Camp Dennison.—At this point is located the *Dennison* U. S. G. Hospital. It is about 16 miles from Cincinnati, on the Little Miami Bottoms, and about 25 feet above the river bed. The soil is calcareous, being underlaid with limestone. The hospital inclosure contains 180 acres of bottom land. Through it passes a shallow ravine, a drainage line from the adjacent hills to the river. The northern fifth of the grounds, previous to draining them in the spring of 1863, with open ditches, was damp, the surface water standing till evaporated, the natural surface drainage being very poor. The wards standing on this soil were found to be unhealthy, the inmates being very subject to intermittent fever. Since it was drained the wards have been empty. The soil over this portion of the grounds, wherever it is exposed by eve drains, ditches, &c., becomes, during the months of July, August, September, and October, covered with a green, cryptogamic vegetation, which, in places, becomes of an ink-black colour. This vegetation is composed mostly of confervoid filaments, which are frequently terminated when mature by sporangia. These sporangia are noticed when the vegetation has assumed an ink-black colour, with a metallic lustre. Mixed with these filaments are numerous palmelloid plants of two species, one green and the other brick-red. When mature these plants, as they become dry, send off multitudes of minute spores, which are elevated in the night exhalations.

There is also met with on calcareous soils another species, of a metallic lead colour by reflected light. By transmitted light they have a dirty, brownish-green colour.[1]

[1] It may be here remarked that *Palmellæ* belong to the lowest known vegetable organisms. The several forms of this type which are constantly attendant on intermittent malarial disease have received the generic name *Gemiasma* (earth miasm).

Gemiasma (Salisbury). Plants having the appearance of cells, each consisting of a thin outside wall, inclosing an inside cell filled with minute spores, either single or aggregated, multiply by duplicative, segmentative within a parent mem-

So far as I have examined (and my observations have been widely extended), I never have found a case of ague, *in situ*, where I did not find

brane, and also developed from spores. Colours various, as red, green, yellow, white, plumbeous, &c.

There are several species which seem to act as malarial poisons. The brick-red, green, and plumbeous plants are principally found upon rich calcareous soils; while the greenish-yellow and white varieties are found mostly upon non-calcareous ground.

G. rubrum (Salisbury). Colour, brick-red. Gives the soil the appearance of having been sprinkled over with brickdust. Produces intermittents of a congestive type.

G. verdans (Salisbury). Colour, green.

G. paludis (Salisbury). Colour, greenish-yellow. Found mostly on non-calcareous soils.

G. plumbous (Salisbury). Colour, plumbous by reflected, and a dirty brownish-green by transmitted light.

G. alba (Salisbury). Colour, greenish or yellowish-white.

In all these species the mass of the visible dust, or incrustation upon the soil, is usually made up of incalculable multitudes of minute spores that have escaped from the plants beneath them. These most minute of all known organic cells are the organisms that are elevated in the night earth exhalations.

Another type consists of jelly-like protuberances, single or in groups, made up of a thin external membrane inclosing a highly transparent, gelatinous material filled with minute double walled spores. This type has received the generic name *Protuberans*.

Protuberans (Salisbury). (Ag. gave this name to a species.)

In these the double walled spores are developed in a highly transparent jelly-like frond, surrounded by a delicate membrane. These are various shades of green, yellow, brown, and, perhaps, other colours.

Another type of plants seem to multiply by the extending laterally of a thin lamina or gelatinous layer, which, like the protuberant variety, consists of an outside parent membrane, within which is a gelatinous matter, filled with a multitude of minute double walled spores, which escape in vast numbers as the lamina dries. This type has received the generic name *Lamella* (Salisbury).

All these genera have spores of a similar structure. The spores are mostly oval, or more or less oblong, and have double walls. The spores of the Protuberans are larger than those of the other genera, and the space between the nucleus and outside cell-wall is more marked.

In the Palmellæ there are two modes of propagation, one by division and the other by spores, and both of these are often common in the same species. These plants are very prolific, springing into existence in a few days in vast multitudes, during the hot summer months, on the drying beds of ponds, stagnant pools and ditches, on the broken soil of humid low grounds, and new prairie lands in malarious districts.

The species are many, all of which have heretofore been regarded as innocuous. There is strong evidence for believing, however, that the minute species that are developed in such abundance in the above-named localities, and the spores of which become elevated and suspended in such multitudes, in the heavy humid night exhalations of ague districts, are decidedly poisonous to the epithelial surfaces with which they come in contact, and are the true source of intermittent and remittent fevers.

these plants growing near; and *vice versa*, I never have found these plants growing in any locality but that (if such locality was inhabited) intermittent or remittent fever, or both, prevailed in proportion to their extent and profusion.

As early as the dry warm weather of spring and summer evaporates the surface water, and begins to dry off the recently exposed soil of rich humid low grounds and peaty bogs in certain localities; a peculiar white, green, or yellowish, or greenish-white, or brickdust powder, will be noticed making its appearance upon the surface. This is thicker in such places as have been recently broken, exposing fresh earth. It also varies considerably in appearance, according to age, rapidity of surface drying, and peculiarity of soil. It is not confined to desiccating peaty bogs and humid low grounds, but is common to the drying beds of streams, pools, ponds, and ditches, and also to calcareous soils, and even sandy plains in humid localities.

On the drying of the newly exposed soil of rich prairie lands and humid low grounds, this vegetation appears white and much thinner than on desiccating peaty bogs. This difference arises from the development on the latter of some larger species than grow upon the former, while the small species of the former are common to the latter. These plants occupy the projecting points and prominences of the soil, and resemble to the unaided eye, an incrustation of saline matter. During the drying of the soil, these plants develop rapidly, and as rapidly disintegrate and set at liberty their spores, which become elevated and suspended in the damp, heavy night exhalations. These exhalations, suspending their palmelloid cells and spores, rise, usually, so that their upper surface in the Northern and Western States, is marked by a plane varying from thirty-five to sixty feet above the surface of the ague grounds. The upper surface of these exhalations describes a horizontal plane, stretching away from the place of origin, in the direction traced by the wind. The spores and cells of these palmellæ are found diffused throughout these vapours, but do not extend above them. They occur, however, more abundantly at and near their upper surface, than lower down. This will explain the singular fact often noticed, that at a certain distance above the ague bottom, along the side hill, malarious diseases are frequently worse than on the bottoms themselves. The zone occupied by these exhalations has a temperature and hygrometric condition of its own; differing materially from the stratum of atmosphere resting immediately upon it, which is much warmer and dryer.

Plants in the Urine of Ague, which act as an Exciting Cause.—The urine of several hundred cases of intermittent and remittent fever has been subjected to careful microscopic examination, with the view of arriving at general results, as to the abnormal bodies present. The urine was in some cases voided before treatment had commenced; in others, after treatment had been continued for some days, without breaking the paroxysms; and

in others the paroxysms had been broken for the time with quinia, while the fever poison still remained in the system. The urine was voided, either in the algid, febrile, or sweating stage of the disease; between the paroxysms, or after the paroxysms had ceased for some days. The results of these examinations are highly interesting. They establish the fact that ague plants, the same as grown upon the ague soil, are constantly developing in the system of the intermittent fever patient; and that the urinary organs constitute one important outlet for the elimination of this fever vegetation. That the urinary organs, with the perspiratory apparatus, are the important channels through which nature strives to rid the organism of the exciting cause, and through which the physician should operate by all the medicinal means at his disposal, to eradicate the disease. They explain to us the important reason, why it is that quinia breaks the continued recurrence of the paroxysms, while it does not eradicate the poison; and why diuretics and diaphoretics and expectorants are such all important aids in eliminating from the system the malarial cryptogams. While quinia braces up the system by its powerful tonic action upon the organizing processes of the epithelial tissue, and through this imparts such tonicity to the nervous system as to enable it to resist the paroxysms, it is well known not to exterminate the exciting cause; although it may control for a time their further development, in the same way that it checks the multiplication of yeast plants in fermentation.

This exciting cause must be carried out of the organism through those excretory channels which nature has provided for the elimination of effete and abnormal products. The principal of these are the perspiratory apparatus, the mucous surfaces and urinary organs. That the perspiratory apparatus performs in this disease an important office, in this eliminating process, we should long ago have understood, from the fact that through this excretory system nature so powerfully acts in her efforts to eliminate the abnormal and poisonous products of the disease. The sweating stage of the paroxysm of ague is essentially a curative one.

These examinations have also established the fact, that in intermittent fever conditions, torula cells are present, indicating the presence of glycogenic matter in the urine. Cholesterine is also uniformly present in this excretion in ague. Both glycogenic matter and cholesterine are found in the liver and spleen. The spleen is the great manufactory of cholesterine,[1] and at the same time organizes some glycogenic matter, as is evident from the development of torula cells in the spleen, when it is removed from the body and allowed to ferment.[2] The liver is the great apparatus for organizing glycogenic matter. The kidneys never normally organize or excrete these bodies. In intermittent fever, we see then, that the functions

[1] See my papers on the Minute Structure and Functions of the Liver and Spleen.
[2] Ibid.

of the liver and spleen, of secreting glycogenic matter and cholesterine, are in part taken on by the kidneys; indicating, perhaps, something like a metastasis of function; and pointing us to these organs for disturbances that are excited by the cryptogamic poison of ague.

There is also found quite uniformly in the urine the spores of a species of fungus—generally vegetating—belonging to the genus *Sphærotheca;* and which is uniformly found growing on and in the larger species of palmellæ, belonging to the genus *Protuberans*, and also in the apple, pear, and quince, producing decay in these fruits. I do not know that this plant produces any abnormal influence upon the system, as it is often met with in the urine of healthy persons.

The ague plants occur in the urine in the form of little cottony flocks, so small that they are scarcely noticeable by the unaided eye, and too few in number to communicate turbidity to the excretion. They vary greatly in amount present in different cases. They are uniformly more abundant when the disease is severe and has continued for some time. They are very light in colour, highly transparent, and appear to be developed in the bladder, pelves of kidneys and ureters, often in considerable numbers. In some cases of ague of long standing, yeast plants, species of *Pennicillium* and *Aspergillus* are also found, developing in large numbers, the mycelia often rising to the surface, a short time after the urine is voided, producing fertile threads and fruit. These plants were found largely developing in the urine of several patients, in the month of September, who had been labouring under the disease most of the summer. In several instances of this kind, I have known the intermittent to merge, after some weeks, into continued fever of a typhoid type. In all cases of this kind, the patients had been receiving constant accessions to the disease, by being exposed daily to the exciting cause.

Plants in the Urine of Intermittent Fever, Consequent on Peculiar Pathological States.—In the urine of all cases of intermittent fever, the spores of Pennicillia are present, indicating the presence of glycogenic matter undergoing fermentative changes. These cells are generally more abundant in obstinate types, and in cases of long standing, than in the milder forms and recent cases.

In several instances, in observations, where the patients had been labouring under severe and obstinate forms of the disease (such as were exposed to constant accessions) for many weeks, tending to typhoid states of the system, the urine was found containing numerous vegetating fungoid filaments, which were the developing Mycelia of Pennicillia, Aspergilli, or Sphærotheci. In these obstinate cases of the disease, the urine passes rapidly to the acetous fermentation even before it is voided, ushering in filamentous development in the cryptogams present. This fermentation progresses so rapidly, that in a few hours after the urine is voided, putrefactive fermentation begins, and small white cottony flocks or tufts of fertile

threads appear above the surface. These soon bear spores, when the plants are discovered to belong either to the genus Pennicillium, Aspergillus, or Sphærotheca.

There is a beautiful species of Pennicillium often present, having symmetrical heads, the stem dividing first into four equal pedicels, which ascend close to each other, and soon subdivide each into four pedicelets, each one of which bears a long moniliform line of spherical spores. I do not know that these cryptogams are at all injurious of themselves in the urine; but they indicate the presence of glycogenic matter and rapid fermentative changes, which are abnormal. They are probably merely the consequences and not the cause of the existing pathological states.

Experiments Relative to the Production of Intermittent Fever.— With the view of obtaining still more positive evidence of the intimate relation between the cause of intermittent fever and the cryptogam developing upon drying humid soils, &c., I filled six tin boxes with the surface earth from a decidedly malarious drying prairie bog, which was covered completely with the palmellæ previously described. Cakes of the surface soil were cut out, the size and depth of the boxes, and fitted carefully in, without disturbing more than possible the surface vegetation. The covers were then placed on, and the boxes transported to a high, hilly district, some five miles distant from any malarious locality, and where a case of ague had never been known to occur. The locality was over three hundred feet above the stream levels, was dry, sandy, and rocky. I here placed the boxes of cryptogams on the sill of an open second-story window, opening into the sleeping apartment of two young men; removed the covers and gave particular directions that the boxes should not be disturbed, and the window left open. On suspending a plate of glass over the boxes on the fourth day, during the night, the under surface of the plate, the following morning, was found covered with palmelloid spores, and numerous cells of the same kind adhered to a suspended plate in the room, which was moistened with a concentrated solution of chloride of calcium.

On the twelfth day one of the young men had a well-marked paroxysm of ague, and on the fourteenth the other was taken down with the disease. They both began to feel unnatural and dull about the sixth day. All three stages of the paroxysms were well marked. The type in both cases was tertian, and was readily controlled by the appropriate remedies.

Four members of the family slept on the lower floor of the house, but none of them were affected.

The experiment was repeated at another point, in the same neighbourhood, where one young man and two boys were exposed in the same way as described in the previous case. In this instance, the two boys were taken down with the disease; one on the tenth and the other on the thirteenth day of the exposure; while the young man escaped.

On account of other duties, and the difficulty of obtaining the consent of parties for experiments, I have been unable to conduct this part of the examination further. The experiments thus far, however, are most highly interesting and confirmatory of the previous observations and results of this extended inquiry, on which nearly three years of almost constant labour have been bestowed.[1]

Pathology of Intermittent Fever.—The lesions in intermittent fever are confined mostly to epithelial structures, showing quite conclusively that the exciting cause acts primarily upon the parent epithelial cells; or, those cells that either organize the products that nourish the several tissues, or disorganize those of interstitial decay, so as to prepare them for ready elimination.

These derangements consist in the altering and enlarging of glandular structures, and in inflammations and alterations in structure and function of the mucous, epidermic, and serous surfaces. All other abnormal manifestations are either symptomatic of these, or are the result of previous disease in the organism.

All the glands in the body belong, strictly, to epithelial tissue, and are made up mostly of parent epithelial cells. These structures are affected in time and extent apparently in proportion to their importance in either organizing and assimilating products for nutrition, or disorganizing those for elimination.

Of all the lesions met with in fatal cases, those of the spleen and liver —most important organs of the body—are the most frequent. The spleen increases in bulk and consistence; its structure is easily torn; its interior often being found to be broken down, and composed of a blackish-red pulpy mass, with which are mingled fibrinous portions of a lighter colour.

Morgagni gives one case where the spleen weighed eight pounds; and another is mentioned by Bailly that weighed nearly ten pounds, the structure being entirely converted into a pulp. The spleen has been occasionally ruptured, and the broken-down and altered tissue emptied into the abdominal cavity. This indicates an altered condition in the organizing processes of the parent epithelial cells of the organism, by which the fibrinous matters and other products of the blood formed, become deposited in the splenic tissue, thus producing enlargement (so-called ague cake) which often, if the patient is not removed from constant accessions to the disease,

[1] Another interesting instance of the production of ague paroxysms by this vegetation, occurred since this paper was partially in type. After exhibiting, about the first of November, a large pan of soil, covered with this vegetation, to the class in one of my lectures, I placed it under the working-table in Dr. House's office. It was loosely covered with a newspaper, and forgotten. In a few days the doctor began to have pains in the back and limbs. These symptoms were soon followed by a well-marked paroxysm of ague. As soon as this occurred the pan of plants came to mind and was removed.

and the exciting cause not eliminated from the organism, results sooner or later in disorganization, and frequently in disintegration of the gland. The liver is also in some cases found greatly enlarged, but altered but little in structure. In others it is softened or filled with black blood, or tuberculated, or containing purulent deposits.

The pancreas is also frequently hardened, so as almost to resemble scirrhus. The mucous membrane of the stomach, duodenum, and small intestines are likewise sometimes involved.

The mesenteric glands are frequently enlarged, and are subject to very nearly the same derangements in function and structure as the spleen.

The exciting cause, inhaled, taken into the system in food and drinks, and absorbed by the skin and mucous surfaces, comes in direct contact with the epithelial cells, spread over and covering the entire body, both internally and externally, wherever there are any ways by which external bodies may enter the organism. The epithelial cells, hence, make up the first tissue of the system with which these poisonous bodies come in contact. These cells they have to pass through before they can enter the systematic circulation and reach the vascular tissues. In passing through these cells, they derange them so as to poison the products they organize. In this way the other tissues, including the ganglionic and cerebro-spinal systems, become involved. As the epithelial cells of the glands, especially those of the spleen, mesentery, and liver, are the most largely engaged of any in organizing nutrient products for the other tissues, these glands are the most severely taxed, and are the first to suffer extensively from the poisonous palmellæ, and hence it is that in these we find so frequently grave lesions.

When the tissues have become poisoned to a certain extent, there is a reaction on the part of the system, an effort of nature to eliminate the poisonous products already in the body. This effort is the paroxysm, which constitutes what we call the disease.

We can readily see how it is that the blood of the body should become thin (deficient in fibrin) as soon as the functions of the spleen are partially or wholly suspended. This being the gland which organizes fibrin more largely than any other, if its function in this respect be suspended by the blocking up of the *oval splenic bodies* with partially organized fibrin, one great source of this product would be cut off from the blood. The fibrin already in the blood becomes deposited in the tissues, and one important source being cut off, the blood becomes thin and deficient in this body. This thin blood fills up all portions of the organ not occupied by masses of fibrin, and hence the ease with which the blood contents of the spleen may be washed out. Whenever the whole mass of the blood of the body becomes very abnormally thin, we may look to the spleen for the primary lesion.

Some of the interesting symptoms of intermittent fever, where the spleen

is involved, Dr. Tweedie says, are "depression of spirits, torpor of mind, inactivity of body, with much muscular debility, deadly paleness, or a yellowish hue tending more to black or green than in ordinary hepatic disease. There is great liability to hemorrhage from various regions of the body, to dropsy, to dysentery, and to ulcers of the legs. The spleen is liable to take on a morbid condition in continued fevers, as well as in intermittents. Diseases of the heart, stomach, and liver, are liable to be accompanied by diseases of the spleen. The spleen is more liable to be affected with disease in damp, marshy localities than in other situations. In intermittent fevers there is a diminution of red globules and fibrin. Softening and the breaking down of the spleen are common in intermittent and continued fevers, in scurvy, and in some varieties of malignant dysentery."

By understanding the true functions of the spleen, these symptoms and lesions are all traceable to their true cause.

Depression of spirits and torpor of mind may arise from either oxaluric or phosphatic states, or from a defective or suppressed organization of some of the nutrient products of nerve tissue; inactivity of body and muscular debility, from a deficient supply of fibrin to muscular tissue; the yellowish hue, to a defective supply of red globules; the great liability to hemorrhage in different parts of the body, dropsy, and dysentery, to thinness of the blood, and the defective supply to it of its normal products.

The probable reason why the spleen is so liable to take on a morbid condition in continued fevers as well as in intermittents, is that the exciting causes of both affect primarily the epithelial tissue, and have a tendency to derange those portions most which are the most actively engaged in organizing nutrient products, the reason of which appears to be that the exciting causes exist alike in the materials we eat, drink, inhale, and absorb through the skin.

The reason why the spleen is more liable to be affected in damp, marshy localities than in other situations, is, that in the former districts, miasmatic poisons impregnate more or less the air, the water, and the food.

The reason of the diminution of fibrin and red globules in the blood in intermittent fever is the greater or less suppression of the normal functions of the spleen and mesenteric glands.

Treatment.—Since nature in the last stage of the paroxysm excites all the excretory organs of the body, and especially the perspiratory, urinary, and mucous surfaces generally; and as these excretions contain spores and plants of the ague palmellæ, it is evident that the sweating stage is a curative process. If so, it points us to important medicinal means as aids in eradicating the poison. These are diuretics, diaphoretics, expectorants, and alteratives. While we should keep quinia constantly in the front rank to impart tonicity to the ganglionic and cerebro-spinal systems and to the epithelial tissue and to control in the body cryptogamic development, we should use diaphoretics, diuretics, and expectorants freely as eliminators.

The nightly sweating of a patient labouring under this disease, might be supposed to result in enervating the system. The reverse, however, is the case. Under active nightly diuresis and diaphoresis, in ague, the sallow countenance rapidly clears up; the dull eye becomes bright; the depression of spirits and torpor of mind and body disappear, and give place to the elastic step and tonicity of muscle. The result is, that, even when the system is exposed to constant accessions, the paroxysms are not only avoided, but organic lesions, and the long train of unpleasant symptoms are not allowed to get their hold upon the system, the ague poison being eliminated as fast as taken into the organism.

In cases where the patient is removed from the exciting cause, the system is soon thoroughly cleansed, and no ague returns the following spring unless there are new exposures.

The power of the system to resist the paroxysms of ague varies greatly in different individuals, and even in the same individual at different periods. This power of resistance is directly proportioned to the tonicity of the system. Habits of bracing, active exercise, such as horseback riding, will often protect the system against attacks. This is noticed in a marked degree in the cavalry and infantry service of the army. In malarious localities, the former are seldom attacked, if on active duty, with intermittent fever; while the latter are extremely liable to suffer. This is the case when both branches of the service are occupying the same malarious district, and are equally exposed.

Quinia, as a prophylactic, enables the system to resist the paroxysms. It braces up the system, and controls cryptogamic growth till nature can effect a cure by eliminating the malarious cause through the skin, mucous surfaces, and kidneys. Quinia, then, is not, strictly speaking, a curative or specific agent, but simply acts beneficially by controlling cryptogamic development, and imparting such tonicity to the organism as enables it to resist the paroxysms, till aided nature can cure the disease by eliminating the cause. Any cause that enervates the system in malarious regions, tends to bring on the paroxysms earlier than they otherwise would appear. Very frequently it is noticed, especially when the system has been under the influence of the disease for some time, and most especially if the disease is contracted in a region where there is a tendency to congestive paroxysms (limestone regions especially) as in the southern part of Tennessee, in Mississippi, and Louisiana, quinia appears at first to have some influence in enabling the system to resist the paroxysms, but soon loses almost entirely its power. In fact, in many instances, it really aggravates the paroxysms, as is evidenced by stopping the quinia entirely. In such cases the skin will be found dry, the mucous surfaces less active than normal, and covered with a scant, clammy mucous secretion, and the renal excretion small; in fact, all the eliminating organs have their functions deranged and their normal action partially suppressed. As long as these are in this condition, the

malarious poison is hemmed up in the organism, so much poisoning the tissues, that the tonic influence of the quinia rather tends to aid, frequently, the abnormal actions than to restore the normal tone. If, however, the normal functions of the kidneys, skin, and mucous surfaces are restored, with diuretics, diaphoretics, and expectorants, and the spleen and liver properly attended to, quinia again will act beneficially and impart its usual tonic effects and the disease will soon be eradicated, especially if the patient be removed from constant accessions.

It is highly important to constantly endeavour to keep the eliminating organs in a healthy and rather increased state of action, when the system is under the influence of any malarious poison, as it is through these channels that the causes are eliminated. We have, then, in this disease, no such thing as a specific in *quinia*. It simply imparts tonicity to the system, and controls cryptogamic development, till Nature, aided by remedial means for exciting the excretions, is able to eliminate the poison.

These principles should be strongly impressed upon the mind of the physician who has charge of malarious diseases. Many old and obstinate cases of ague, with the system filled with the malarious poison, and all the channels of egress closed, are being daily dosed largely with quinia, arsenic, and iron, with little or no effect, with the view of curing the disease in some empirical and mysterious way by these so-called *specifics*. The very name *specific* should be blotted from medical science, and left entirely to the *quack*, who knows nothing else. There is really no such thing in medicine. All we can do in any disease is to aid Nature, and to follow her as closely as possible in her curative processes, and this we can only do wisely and well, by understanding fully the true cause and pathology of every disease we treat.

In treating intermittent fever, it is of the first importance to correct any abnormal condition of the portal system, and to accompany this by diuretic, diaphoretic, and expectorant remedies, to excite into activity all the eliminating organs of the body. It is impossible to mark out a fixed course for all cases. The following prescriptions will, however, illustrate the general plan of treatment:—

℞.—Potass. acetat. ℥ij; spts. nitr. dulcis ℥j; syr. scill. comp. ℥ss; aquæ menth. pip. ℥viij.—M. S. Take from one to two tablespoonfuls, in a glass of water, morning, noon, and night. Every evening, on retiring, take a warm diaphoretic draught.

Also, ℞.—Quiniæ sulph. gr. xxxij; strychniæ sulph. gr. ¼; mass hydr. gr. vj; pulvis capsici gr. xx; ferri lactat. gr. xx; ext. gentian. syrup. āā q. s.—Make pills xxxii. S. Take two pills every two hours till sixteen are taken. Every day or every other day after, according to the type of the disease, take four pills two hours before the time for the paroxysm. At the end of ten days, take two pills every two hours till sixteen pills are taken, and continue as before for ten days more, then take

sixteen more pills. By this time, if the eliminating remedies are kept faithfully up, the patient will be thoroughly cured, if he is not exposed to constant accessions. If he is, the eliminating organs must be constantly kept excited, that the cause may be removed as fast as it enters.

Under this treatment a paroxysm need never occur after the commencement of the remedies.

The means are within our reach for *removing the prolific cause* of intermittents. Rich, humid, low grounds, which produce ague plants abundantly when they are new, undergo some change by culture and drainage, that unfit them for the growth of the palmellæ. As the malarious portions of the country become older, and the low, humid, rich grounds become drained and cultivated, ague districts will become more and more circumscribed, and intermittents proportionally decrease. As long, however, as there remain in such localities, pools, ponds, ditches, and streams, the beds of which are liable to become more or less dry during the warm summer months, intermittents may be expected, to a certain extent, to prevail. These sources of the disease, however, may be much lessened by turning the open ditches into blind ones, draining pools, swamps, and ponds, and subjecting the soil of their beds to repeated cultivation. By this process, intermittents, which now extensively prevail over a large portion of our richest districts, may be so circumscribed in their limits as to be no longer a dreaded accompaniment to the most fertile agricultural sections of our country.

Where it is necessary to make excavations, during the warm, dry months, in new, rich, humid soil, the bottoms and sides of these excavations, with the earth removed, should, at the close of each day's work, be plentifully sprinkled over with caustic lime. If this precaution be well attended to, the ague plants will not develop. It is also highly desirable, in making ditches through malarious soil, to keep the bottom, sides, and thrown-out earth well sprinkled with lime.

As fast as the beds of streams, ditches, pools, and ponds, in ague districts, become dry, they should also be well strewn with caustic lime. This is especially desirable, in this climate, during the months of July, August, and September.

When new prairie land, or new, humid, low ground, is being turned up for the first time, and lime can be readily obtained, it will save much sickness by sowing it over with a good top dressing of caustic lime. If one application is not sufficient to check the growth of ague plants entirely, a second should be made. This application will by no means be lost on the soil, as it serves to neutralize acidity, convert resinous matters into soluble soaps; and the soil is thereby rendered more fertile, and that its increased and better crops will more than pay for the lime application. If lime cannot be obtained, wood-ashes may be used, though their effect will not be as marked or enduring. In selecting camping-grounds for armies, or locations for

hospitals, new soil and low prairie, or other humid grounds, should be avoided as much as possible. Wherever open ditches are made, streets excavated, wells and cellars dug, or new earth thrown up or exposed in any way to the drying influence of the sun and atmosphere of May, June, July, August, and September, and especially during the two latter months, if the region is at all malarious, caustic lime should be freely strewn over all such excavations, and over the heaps of soil removed.

Influence upon the System of the Pollen and Volatile Principles of Phænogams when inhaled.—The spores and exhalations of cryptogams are not the only bodies in the atmosphere that excite, when inhaled, abnormal and diseased conditions. During the active flowering of phænogams, the air becomes loaded in their vicinity with the pollen of the flowers, and volatile principles of the plants. These matters are inhaled in large quantity by those breathing the atmosphere containing them. If the plants produce no innocuous or active medicinal principle, the pollen and exhalations, except in particular instances hereafter referred to, have no abnormal influence upon the organism. But if they produce poisonous products, or active medicinal agents, the influence of the pollen and volatile principles inhaled is readily felt.

In passing through or past a field of hops, lettuce, or poppies, in flower, a sensation of drowsiness is soon felt, accompanied often by lassitude and indisposition, either to mental or physical action. In passing through a field of stramonium in bloom, or tobacco, similar sensations follow, with nausea, weakness, a tired sensation about the eyes, followed by pains in the head, &c. In passing among the plants of conium maculatum in flower, drowsiness, with a stiffness of the eyes, followed by swelling of the orbital tissues, and a dull pain in the eyeballs and forehead are the result. These symptoms vary much in severity and duration, according to the time the system is under the influence of the deleterious agents, and the quantity inhaled and absorbed by the surface.

In passing among poison ivy (*Rhus vernix*) when it is in flower, the effects are often so powerful, especially when the air is damp, and during the night, as to produce extensive œdematous swelling and inflammation resembling erysipelas. The pollen of several species of lobelia excite nausea and giddiness. There are many other plants that possess powerful medicinal and poisonous agents, growing in our forests and upon our prairies, the pollen and volatile principles of which, when inhaled, produce marked derangements.

Many exotics of the greenhouse come also under this head. The flowers of all such plants should be avoided as much as possible. Many of those unpleasant sensations experienced by travellers and explorers in a new country, while passing among luxuriant plants and beautiful flowers, arise from the inhalation of the pollen and volatile principles of this vegetation.

No doubt many diseased conditions may have their origin in such exposures.

Dr. Isaac Hays, editor of the *American Journal of the Medical Sciences*, detailed to me, a short time since, some most interesting instances, that had fallen under his observation, of the influence of the pollen of the rose, and also several cases of the influence of the pollen of, and exhalations from, the cereals and other phænogams upon particular persons.

The exhalations from certain plants, when not in flower, produce, on some persons, marked effects. As an instance of this, the poison ivy (*Rhus vernix*) may be mentioned as producing violent symptoms of poisoning, in certain cases, without ever coming in contact with the plant. Such susceptible persons are able to distinguish its presence before they are able to see the plant, by the effect of the air upon them.

Some are highly susceptible to ipecac, it producing peculiar symptoms upon them by simply being in the room with it. Calomel will also frequently excite temporary salivation and nausea in some by simply handling it.

Numerous other instances might be added to those already briefly referred to, to show the effects, upon either some or all systems, of extremely minute portions of certain bodies when inhaled. It indicates to us the probability that the atmosphere may contain many of those subtle causes of disease, which have thus far eluded the search of so many long and patient inquirers.

In conclusion, I may state that this paper presents merely a brief of the investigations in this direction. All the microscopic descriptions, with six plates of illustrations, and many detailed observations and experiments, are omitted, on account of the whole being too long for an article in a medical journal.

ART. III.—*An Inquiry into the Causes of Certain Diseases on Ships of War.* By EDGAR HOLDEN, M. D., late Assistant Surgeon U. S. Navy. Read before the Essex Medical Union, of Newark, N. J., and published by request of the Society.

IT is not designed in this article even to touch upon the interminable discussions regarding the construction, regulation, and climatic liabilities which may, upon ships in general, act as causes of disease, or to discuss, so far as it is possible to avoid it, those common well-known diseases peculiar to men congregated in restricted quarters, but to review briefly and present as concisely as possible, *three* maladies most prominent upon our national vessels and on our own coast during the past four years. Even